# 1999 Annual Report

# NARMS

## National Antimicrobial Resistance Monitoring System: Enteric Bacteria

CDC

CENTERS FOR DISEASE CONTROL AND PREVENTION

# 1999 National Antimicrobial Resistance Monitoring System (NARMS) For Enteric Bacteria Participants (Human Isolates)*

Centers for Disease Control and Prevention

Frederick J. Angulo, Nina Marano, Shannon Rossiter, Jennifer McClellan, Thomas J. Van Gilder, Karen Stamey, Kevin Joyce, Richard Bishop, Tim Barrett, Joy Wells, Foodborne and Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases; National Center for Infectious Diseases

US Food and Drug Administration

Marcia Headrick, Kathy Hollinger, Linda Tollefson, Office of Surveillance and Compliance, Center for Veterinary Medicine

Participating Local and State Health Departments

California Department of Health Services
Sharon Abbott, Paul Kimsey, Sue Shallow, Duc Vugia, Jim Ware

Colorado Department of Public Health and Environment
Mike Rau, David Butcher, Carol Hoff, Richard Hoffman

Connecticut Department of Public Health
Bob Howard, Don Mayo, Terry Fiorentino

Florida Department of Health
Jody Baldy, Rima Farah, Ronald Baker, Richard Hopkins

Georgia Division of Public Health
Marsha Ray, Mahin Park, Suzanne Segler, Elizabeth Franko, Paul Blake

Kansas Department of Health and Environment
Robert Flahart, June Sexton, Roger Carlson, Gianfranco Pezzino

Los Angeles County Department of Health Services
Liga Kilman, Elizabeth Cordero, Joan Sturgeon, Mary Dorado, Deborah Brown, Laurene Mascola

Massachusetts Department of Public Health
Joseph Peppie, Alfred DeMaria, John Fontana, Robert Goldbaum

Maryland Department of Health and Mental Hygiene
Yongyu Wang, Judy Johnson, Glenn Morris

Minnesota Department of Health

Fe Leano, Julie Wicklund, John Besser,

New Jersey Department of Health
Keith Pilot, Sylvia Matiuck, John Brook

New York City Department of Health
Alice Agasan, Wydenia Perry, Mel Backer, Marci Layton

New York State Department of Health
Tim Root, Shelley Zansky, Amy Davignon, Dale Morse

Oregon Department of Human Resources
Steve Mauvais, Maureen Cassidy, Theresa McGivern, Beletsachew Shiferaw, Paul Cieslak

Tennessee Department of Health
Henrietta Hardin, Cynthia Graves

Washington Public Health Laboratories
Jay Lewis, Donna Green, Jon Counts, Craig Columbel

West Virginia Department of Health and Human Resources
Doug McElfresh, Loretta Haddy, Mary Connie Smith

* Information on animal isolates is available at
www.nps.ars.usda.gov/projects/projects.htm?accession=402399

**Page Number** **Figures**

**National Antimicrobial Resistance Monitoring System For Enteric Bacteria**

# 1999 Annual Report

## Summary

In 1999, 1499 non-Typhi *Salmonella* isolates**,** 166 *Salmonella* Typhi isolates, 375 *Shigella,* 292 *E. coli* O157 isolates, and 319 *Campylobacter* isolates from humans were tested by the National Antimicrobial Resistance Monitoring System (NARMS) for Enteric Bacteria. Twenty-six percent of non-Typhi *Salmonella* isolates were resistant to one or more antimicrobial agents. Among *Salmonella* serotype Typhimurium isolates, 49% were resistant to one or more antimicrobial agents. Twenty-eight percent of *Salmonella* Typhimurium isolates had the multidrug-resistant pattern characteristic of DT104; resistant to ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline (ACSSuT). One *Salmonella* isolate was resistant to ciprofloxacin (*S.* Senftenberg). The percentage of non-Typhi *Salmonella* isolates with ciprofloxacin minimum inhibitory concentrations (MICs) $\geq$0.25 µg/ml increased from 0.4% in 1996 to 1.0% in 1999. The percentage of non-Typhi *Salmonella* isolates with a ceftriaxone MIC $\geq$ 16 µg/ml increased from 0.1% in 1996 to 2% in 1999. Among *S.* Typhi isolates, 29% were resistant to one or more antimicrobial agents. Among *Shigella* isolates, 91% were resistant to one or more antimicrobial agents. Among *E. coli* O157 isolates, 10% were resistant to one or more antimicrobial agents. Among all *Campylobacter* isolates, 53% were resistant to one or more antimicrobial agents. Among *Campylobacter jejuni* isolates, 54% were resistant to one or more antimicrobial agents; 18% were resistant to ciprofloxacin.

## Methods

NARMS was launched in 1996, within the framework of CDC's Emerging Infections Program's Epidemiology and Laboratory Capacity Program and the Foodborne Disease Active Surveillance Network (FoodNet) as a collaboration among CDC, the U.S. Food and Drug Administration (FDA)-Center for Veterinary Medicine, U. S. Department of Agriculture (USDA)-Food Safety and Inspection Service and Agricultural Research Service, and state and local health departments to monitor prospectively the antimicrobial resistance of human non-Typhi *Salmonella* and *Escherichia coli* O157 isolates. Testing of *Campylobacter* isolates was added in 1997, and testing of *Salmonella* Typhi and *Shigella* isolates was added in 1999. In 1999, there were 17 NARMS health department participants (CA, CO, CT, FL, GA, KS, Los Angeles County, MD, MN, MA, NJ, New York City, NY, OR, TN, WA, and WV), representing approximately 103 million persons (38% of the United States population), and 7 of the 9 U.S. regions [Table 1]. In 1999, seven states (CA, CT, GA, MD, MN, NY, and OR) also monitored antimicrobial resistance among human *Campylobacter* isolates.

In 1999, NARMS participating public health laboratories have selected every tenth non-Typhi *Salmonella,* every *Salmonella* Typhi, every tenth *Shigella*, and every fifth *E. coli* O157 isolate received at their laboratory, and forwarded the isolates to CDC for susceptibility testing. Although we requested that participating laboratories send every *S.* Typhi isolate, analysis was restricted to one isolate per patient. At CDC, a semiautomated system (Sensititre, Trek Diagnostics, Westlake, OH) is used to determine the MICs for 17 antimicrobial agents: amikacin, ampicillin, amoxicillin-clavulanic acid, apramycin, ceftiofur, ceftriaxone, cephalothin, chloramphenicol, ciprofloxacin, florfenicol, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfamethoxazole, tetracycline, and trimethoprim-sulfamethoxazole [Table 2].

Public health laboratories from eight states also select and forward the first *Campylobacter* isolate received each week to CDC for susceptibility testing. For *Campylobacter*, the E-test system (AB BIODISK, Solna, Sweden) is used to determine the MICs for 8 antimicrobial agents: azithromycin, chloramphenicol, ciprofloxacin, clindamycin, erythromycin, gentamicin, nalidixic acid, and tetracycline [Table 2]. After confirmation to genus level, identification of *Campylobacter* to species level is performed using the hippurate test, and, for hippurate-negative *Campylobacter* isolates, and polymerase chain reaction to identify the hippuricase gene, diagnostic of *Campylobacter jejuni*.

For all pathogens in this report, MIC results are dichotomized: isolates with intermediate susceptibility are categorized as sensitive. Breakpoints are determined using, when available, National Committee for Clinical Laboratory Standards (NCCLS) [Table 2].

## Results

### Non-Typhi *Salmonella*

A total of 1514 non-Typhi *Salmonella* isolates were received at CDC in 1999; 1499/1514 (99%) were viable upon receipt and tested for antimicrobial susceptibility [Table 4a, Figure 1]. Non-Typhi *Salmonella* refers to all *Salmonella* serotypes except serotype Typhi. The antimicrobial agents to which *Salmonella* demonstrated the highest prevalence of resistance were tetracycline, sulfamethoxazole, streptomycin, and ampicillin: 292/1499 (19%) were resistant to tetracycline, 272/1499 (18%) isolates were resistant to sulfamethoxazole, 254/1499 (17%) were resistant to streptomycin, and 234/1499 (16%) were resistant to ampicillin [Figure 2]. Figure 3 provides MIC results for each of the 17 antimicrobials tested. One (0.1%) isolate (*S.* serotype Senftenberg) was resistant to ciprofloxacin; 16 (1%) isolates were resistant to nalidixic acid. Six (0.4%) isolates were resistant to ceftriaxone.

Among non-Typhi *Salmonella* isolates, 388/1499 (26%) were resistant to one or more agents, and 315/1499 (21%) were resistant to two or more agents. Among *Salmonella* isolates tested, 269/1499 (18%) were serotype Enteritidis and 362/1499 (24%) were serotype Typhimurium (includes serotype Typhimurium var. Copenhagen) [Table 5]. In 1999, the serotypes with the highest proportion of isolates which were pansusceptible were Javiana (98%), Thompson (97%), and Braenderup (96%) [Table 6]. Figure 4 provides the resistance among non-Typhi *Salmonella* serotypes from 1996-1999. Among *S.* Enteritidis isolates, 44/269 (16%) were resistant to one or more antimicrobial agents. Among *S.* Typhimurium isolates, 179/362 (49%) were resistant to one or more antimicrobial agents [Table 7]. Figure 5 provides the percent of *S*. Typhimurium by site.

In recent years, a multidrug-resistant strain of *S.* Typhimurium has been identified. This strain is characterized not only by the multidrug-resistant pattern, but also by the phage type – DT104 [Table 8]. Although none of 362 *S.* Typhimurium isolates tested were phage typed, 102 (28%) were resistant to the five antimicrobial agents, ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline (ACSSuT), to which *S.* Typhimurium DT104 is commonly resistant [Figure 6]. Of the 102 *S.* Typhimurium isolates with the ACSSuT resistance pattern, 12 (12%) were also resistant to kanamycin, 9 (9%) were also resistant to cephalothin, 7 (7%) were also resistant to amoxicillin-clavulanic acid, 3 (3%) were also resistant to ceftiofur, and 1 (1%) was also resistant to ceftriaxone [Table 9].

A second penta-resistant pattern, resistance to ampicillin, kanamycin, streptomycin, sulfamethoxazole, and tetracycline (AKSSuT), also has emerged among *Salmonella* Typhimurium [Table 8]. Strains with this resistance pattern are not DT104 by phage typing. Among 362 *Salmonella* Typhimurium isolates tested, 39/362 (11%) had the AKSSuT resistance pattern [Figure 7]. Of the 39 *S.* Typhimurium isolates with the AKSSuT resistance pattern, 12 (31%) were also resistant to chloramphenicol, 8 (20%) were also resistant to cephalothin, and 2 (5%) were also

resistant to amoxicillin-clavulanic acid [Table 9]. Table 10 describes the clinical source of all non-Typhi isolates tested in 1999.

One *Salmonella* isolate (0.1%) was resistant to ciprofloxacin [Figure 3i]. The percentage of *Salmonella* isolates with ciprofloxacin MICs $\geq$0.25 increased from 0.4% (5/1326) in 1996 to 1% (15/1499) in 1999 [Table 11]. The percentage of *Salmonella* isolates resistant to nalidixic acid (MIC $\geq$32) increased from 0.4% (5/1326) in 1996 to 1% (16/1499) in 1999 [Figure 3m]. The percentage of *Salmonella* isolates with decreased susceptibility to ceftriaxone (MIC $\geq$16) increased from 0.1% (1/1326) in 1996 to 2% (28/1499) in 1999 [Table 12, Figure 3f]. Seventeen of the 97 (18%) *S*. Newport isolates were highly multidrug-resistant, resistant to amoxicillin-clavulanic acid, ampicillin, ceftiofur, cephalothin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline as well as having decreased susceptibility to ceftriaxone [Figure 4j].

## ***Salmonella* Typhi**

A total of 249 *S.* Typhi isolates were received at CDC in 1999; 207/249 (83%) were viable upon receipt and tested for antimicrobial sensitivity [Table 4b, Figure 1]. Of these 207 isolates, forty-one *S*. Typhi isolates were eliminated from analysis because they were duplicate submissions. Among *S.* Typhi isolates, 49/166 (29%) were resistant to one or more antimicrobial agents and 25/166 (15%) were resistant to two or more agents. The most common resistances among *S.* Typhi isolates were to nalidixic acid 31/166 (19%), sulfamethoxazole 28/166 (17%), or streptomycin 23/166 (14%) [Table 3, Figure 8]. Twenty-one (13%) isolates were resistant to ampicillin; 20 (12%) isolates were resistant to chloramphenicol. Figure 9 provides data on *Salmonella* Typhi MICs by antimicrobial agent. None of the *S.* Typhi isolates tested were resistant to amikacin, apramycin, ciprofloxacin, florfenicol, gentamicin, or kanamycin.

***Shigella***

A total of 377 *Shigella* isolates were received at CDC in 1999; 375/377 (99%) were viable upon receipt and tested for antimicrobial sensitivity [Table 4c, Figure 1]. Among *Shigella* isolates, 341/375 (91%) were resistant to one or more antimicrobial agents and 244/375 (65%) were resistant to two or more agents. The most common resistances among all *Shigella* isolates were to ampicillin 288/375 (77%), tetracycline 215/375 (57%), streptomycin 209/375 (56%), or sulfamethoxazole 206/375 (55%) [Table 3, Figure 10]. One hundred ninety-three (51%) isolates were resistant to trimethoprim-sulfamethoxazole. *Shigella sonnei* isolates were most frequently resistant to ampicillin 219/275 (80%), sulfamethoxazole 150/275 (54%), or streptomycin 143/275 (52%) [Figure 11]. Figure 12 provides data on *Shigella sonnei* MICs by antimicrobial agent. The most common resistances among *Shigella flexneri* isolates were to tetracycline 80/87 (92%), ampicillin 67/87 (77%), or chloramphenicol 56/87 (64%) [Figure 11]. Figure 13 provides data on *Shigella flexneri* MICs by antimicrobial agent. None of the *Shigella* isolates tested were resistant to amikacin, apramycin, ceftiofur, ceftriaxone, ciprofloxacin, or florfenicol.

***E. coli* O157**

A total of 296 *E. coli* O157 isolates were received at CDC in 1999; 292/296 (99%) were viable upon receipt and tested for antimicrobial sensitivity [Table 4d, Figure 1]. Among *E. coli* O157 isolates, 30/292 (10%) were resistant to one or more antimicrobial agents and 12/292 (4%) were resistant to two or more agents. The most common resistances among *E. coli* O157 isolates were to sulfamethoxazole 24/292 (8%), tetracycline 10/292 (3%), and streptomycin 8/292 (3%) [Table 3, Figure 14]. Figure 15 provides data on *E. coli* O157 MICs by antimicrobial agent. None of the *E. coli* O157 isolates tested were resistant to amikacin, apramycin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, or florfenicol.

***Campylobacter***

A total of 393 *Campylobacter* isolates were collected in 1999 and forwarded to CDC; 319/398 (80%) were viable upon receipt and tested for antimicrobial susceptibility [Table 4e, Figure 1]. Of the isolates tested, 295/319 (92%) were *C. jejuni*, 20/319 (6%) were *C. coli*, 2 were *C. upsaliensis*, and 2 were *C. fetus* [Table 15].

Among *Campylobacter jejuni* isolates, 158/295 (54%) were resistant to one or more antimicrobial agents, and 60/295 (20%) were resistant to two or more agents. The most common resistances among *Campylobacter jejuni* isolates was to tetracycline 135/295 (46%) followed by nalidixic acid 59/295 (20%), and ciprofloxacin 52/295 (18%) [Table 16, Figure 17a]. Figure 18 provides data on *C. jejuni* MICs by antimicrobial agent.

Among *Campylobacter coli* isolates, 10/20 (50%) were resistant to one or more antimicrobial agents, and 7/20 (35%) were resistant to two or more agents. The most common resistances among *C. coli* isolates was to nalidixic acid 6/20 (30%), tetracycline 6/20 (30%), or ciprofloxacin 6/20 (30%) [Table 16, Figure 17b]. Figure 19 provides data on *C. coli* MICs by antimicrobial agent.

The NARMS 1997-1999 Annual Reports are posted on the NARMS Website. The address is www.cdc.gov./ncidod/dbmd/narms

# National Antimicrobial Resistance Monitoring System: Enteric Bacteria
# 1999 Publications and Presentations

Publications

1. Zirnstein G, Li Y, Swaminathan B, Angulo F. Ciprofloxacin resistance in *Campylobacter jejuni* isolates: Dectection of gyrA resistance mutations by MAMA PCR and DNA sequence analysis. Journal of Clinical Microbiology 1999; 37: 3276-3280.

Abstracts

1. Dunne E, Fey P, Shillam P, Kludt P, Keene W, Harvey E, Stamey K, Barrett T, Marano N, Angulo F. Emergence of domestically acquired AmpC-mediated ceftriaxone-resistant *Salmonella* serotype Typhimurium (ST) infections. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

2. Fiorentino T, Howard R, Kinney A, Marcus R, Mshar P, Marano N, Westerman J, Reddy S, Angulo F. Routine subtyping of *Salmonella* serotype Typhimurium by PFGE facilitates focused epidemiological investigations in Connecticut. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

3. Fontana J, Bagshaw J, Angulo F, Marano N, Shea D, Goddard A, George H. Plasmid DNA associated with specific bands in PFGE patterns of antibiotic-resistant *Salmonella* serotype Enteritidis. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

4. Hollinger K, Bager F, Marano N, Angulo F, Aaerestrup F, Tollefson L, Gerner-Smidt, Wegener H. Aminoglycoside (AG) resistance in the United States and Denmark: an association between resistance and AG use in food animals, particularly in US poultry sources. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

5. Hollinger K, Silvers L, Marano N, Fedorka-Cray P, Angulo F, Tollefson L, Stamey K. Antibiotic resistance in *Salmonella enterica* Serotypes Heidelberg, Kentucky, and Thompson isolated from human and broiler chicken sources. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

6. Marano N, Benson J, Koehler J, MacKinson C, Wang Y, Madden J, Debess E, Hill B, Archibald L, Boel J, Wegener H, Angulo F. Presence of high-level gentamicin-resistant (HLGR) enterococci in humans and retail chicken products in the US, but not Denmark. In Program and Abstracts of 39th Interscience Conference on Antimicrobial Agents and Chemotherapy, 1999 September, San Francisco, CA.

7. Marano N, Stamey K, Barrett T, Angulo F. High prevalence of gentamicin resistance among selected *Salmonella* serotypes in the US: associated with heavy use of gentamicin in poultry? In Program and Abstracts of Infectious Disease Society of America 37th Annual Meeting, 1999 November, Philadelphia, PA.

8. Marano N, Stamey K, Barrett TJ, Angulo FJ and NARMS: Enteric Bacteria Working Group. The national antimicrobial resistance monitoring system (NARMS): trends in antimicrobial resistance. Emerging Antibiotic Resistance in Foodborne Enteric Pathogens Conference,1999 August, Athens, GA.

9. Marano N, Stamey K, Barrett TJ, Bopp C, Dabney P, Angulo FJ and the NARMS Working Group. Emerging quinolone-and-extended spectrum cephalosporin-resistant *Salmonella* in the United States.. In Program and Abstracts of American Society for Microbiology, 99th General Meeting, 1999 May, Chicago, IL.

10. Marano N, Stamey K, Barrett TJ, Angulo FJ and NARMS: Enteric Bacteria Working Group. Antibiotic resistance among human *Campylobacter* isolates in the United States, 1997-1998. *Campylobacter*, *Helicobacter* and Related Organisms Conference, 1999 September, Baltimore, MD.